

metals, metal oxides, metal sulfides and combinations thereof. Preferred catalysts include mixed nickel and molybdenum oxides or mixed cobalt and molybdenum oxides. The process can oligomerize sulfur compounds so that sulfur-containing feedstocks can be treated without deactivating the catalysts. Accordingly, untreated refinery streams can be used as oligomerization feedstocks without preliminary desulfurization.

New claim 12 has been added to include the limitation wherein the hydrocarbon feedstock comprises about 1 wt.% of sulfur-containing molecules, support for which can be found in the specification at page 11, line 7 and page 3, line 27.

New claim 13 has been added to include the limitation wherein the hydrocarbon feedstock comprises at least 10-100 ppm of sulfur-containing molecules, support for which can be found in the specification at page 6, line 2.

New claim 14 has been added to include the limitation wherein the hydrocarbon feedstock comprises from greater than 50 to 100 ppm of sulfur-containing molecules, support for which can be found in the specification at page 6, line 2. Despite the lack of *in haec verbis* support for the lower limit, it is respectfully submitted that such is inherently supported by the specification. See, *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976) and MPEP 2163.05 III.

New claim 15 has been added to include the limitation wherein more than 95% of said sulfur-containing molecules are converted to oligomers. Support for this is found at page 11, line 13 of the specification.

Rejections Under 35 U.S.C. § 103(a)

Claims 1-11 have been rejected under 35 USC § 103(a) as being unpatentable over newly cited U.S. Patent No. 4,788,376 to Mazurek et al. (Mazurek) in view of U.S. Patent No. 5,157,201 to Norris. Mazurek is cited as disclosing an oligomerization process using propylene feed which uses "all" catalysts effective for oligomerization of olefins to higher hydrocarbons, which catalysts can include heterogeneous catalysts. Mazurek is also cited as teaching

using "oxides of cobalt, nickel, chromium, molybdenum and tungsten on supports such as alumina" as oligomerization catalysts, as well as process conditions which overlap those set out in claims 8, 9 and 11. The Examiner argues that inasmuch as Mazurek does not disclose the use of hydrogen in the oligomerization zone, it discloses oligomerization in the absence of hydrogen. The Examiner acknowledges that Mazurek is silent concerning feedstock containing sulfur and oligomerization of sulfur-containing molecules. Accordingly, Norris is cited as teaching that higher olefin plants typically use a propylene feedstock which normally contains 5-50 ppm of various sulfur species, and that sulfur species are incorporated into higher olefins during oligomerization.

The Examiner concludes it would be obvious to oligomerize sulfur- and propylene-containing feedstocks with the catalysts specified in the present claims in view of Mazurek because Norris teaches use of 5-50 ppm sulfur-containing feeds for oligomerization as well as incorporation of sulfur into higher olefins during oligomerization. The Examiner argues selecting any combination of metals and metal oxides would be obvious to one skilled in the art, including applicants' NiMo/alumina or mixed NiMo or CoMo oxides given the reference teaching that such catalysts are known to accomplish the desired conversion.

This rejection is respectfully traversed.

Mazurek is directed to oligomerizing lower olefin feeds which contain diene impurities using a zeolite oligomerization catalyst. The reference uses a sulfur compound adsorbing catalyst comprising metal oxide to remove sulfur contaminants which may be present in amounts up to 100 wppm of the feed. This catalyst, may be used in a guard bed upstream from the oligomerization zone, or may be mixed with the oligomerization catalyst to adsorb sulfur in the oligomerization zone itself. In contrast, the present invention oligomerizes a sulfur-containing hydrocarbon feedstock with hydrotreating catalyst such as Ni/Mo or Co/Mo mixed oxides supported on alumina in the absence of hydrogen. The sulfur-containing molecules can be oligomerized (claim 3) or converted simultaneously with some or all of the other reactive molecules in the feedstream (page 6, lines 25).

One skilled in the art familiar with Mazurek's teaching to use "all" catalysts which are effective for the oligomerization of olefins to higher hydrocarbons would not be directed to using the hydrotreating catalysts employed in the present process for oligomerizing sulfur-containing feeds despite Norris' teaching that "sulfur species tend to become incorporated in the higher olefins" during oligomerization. This is quite simply because Mazurek teaches a wide variety of oligomerization catalysts and provides no guidance whatever to one skilled in the art to select a catalyst which oligomerizes sulfur-containing molecules. Mazurek is concerned only with removing dienes impurities and in no way discloses or suggests selecting among the many oligomerization catalysts which exist to obtain the results achieved by the present invention. Norris actually teaches away from the present invention's oligomerization of sulfur-containing feeds inasmuch as it teaches that sulfur species incorporated in higher olefins during oligomerization provide a low quality product (column 1, lines 47-48). Instead, Norris encourages removing sulfur from the feed by using a sulfur-compound adsorbing catalyst.

With regard to new claim 12, this combination of references fails to disclose or suggest the use of feeds that contain such high levels of sulfur compounds (about 1 wt. %, i.e., 10000 ppm). Moreover, with regard to new claim 15, it is respectfully submitted that this combination of references neither discloses nor suggests a process wherein more than 95% of said sulfur-containing molecules are converted to oligomers.

It is respectfully submitted that one skilled in the art aware of these two references would lack any meaningful guidance in arriving at the present invention's use of hydrotreating catalyst to treat sulfur-containing compounds by oligomerization over a hydrotreating catalyst. Accordingly, withdrawal of this rejection is respectfully requested.

Claims 1-5 and 8-9 have been rejected under 35 USC § 103(a) as being unpatentable over U.S. Patent No. 4,098,839 to Wilms et al. (Wilms) in view of Norris. Wilms is cited as disclosing oligomerization of C₂-C₅ olefins over a

catalyst containing molybdenum and cobalt and/or nickel supported on alumina which is activated in an oxidizing atmosphere to provide metal oxides. Wilms describes a catalyst "substantially insensitive to sulfur . . . components in the olefin feedstocks" (column 2, lines 10-12) and teaches feedstocks containing 50 ppm sulfur (column 6, lines 21-22). Norris is also cited as teaching that higher olefin plants typically use a propylene feedstock which normally contains 5-50 ppm of various sulfur species, and that sulfur species are incorporated into higher olefins during oligomerization.

The Examiner concludes it would be obvious to oligomerize sulfur- and propylene-containing feedstocks with the catalysts specified in the present claims in view of Wilms because Norris teaches use of 5-50 ppm sulfur-containing feeds for oligomerization as well as incorporation of sulfur into higher olefins during oligomerization. The Examiner argues selecting any combination of metals and metal oxides would be obvious to one skilled in the art, including applicants' NiMo/alumina or mixed NiMo or CoMo oxides given the reference teaching that such catalysts are known to accomplish the desired conversion.

This rejection is respectfully traversed.

Wilms oligomerizes unsaturated hydrocarbons with a molybdenum sulfide catalyst which has been treated in an *oxidizing* atmosphere at 300°-700°C constituting "an intermediate phase between molybdenum oxide and molybdenum sulfide [which] constitutes the active component of the catalyst" (column 3, lines 10-13). Applicants note that Wilms provides comparative Examples 4 and 5 using supported MoO₃ catalyst and MoS₂ catalyst, respectively, to process a feed containing 50 ppm sulfur. However, Wilms teaches that the product yield obtained in the absence of sulfur in the feed "had almost the same composition than the one obtained by Example 1" [with 50 ppm sulfur in the feed] (column 6, lines 26 to 31) which teaches away from the present invention's process which oligomerizes sulfur-containing molecules as set out in present claim 3.

Moreover, Wilms oligomerizes at relatively low temperatures of 40°-180°C (104°-358°F). In contrast, the present invention employs higher

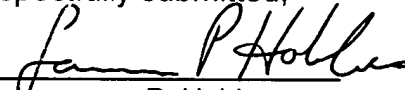
temperatures (392°-600°F) which enhance reactivity of the catalyst to form oligomers at conditions "more severe than typical conditions used to conduct oligomerizations/polymerizations" (specification; page 6, lines 12-15). Finally, it is urged that neither Wilms nor Norris suggests the process of present claim 12 wherein the hydrocarbon feedstock comprises about 1 wt.% (10000 ppm) of sulfur-containing molecules. Nor is the subject matter of claim 15 wherein more than 95% of the sulfur-containing molecules are converted to oligomers disclosed or suggested by the combination of these two references.

Given these distinctions, it is respectfully submitted that the subject matter of the present claims is neither disclosed nor suggested by the combination of Wilms and Norris. Accordingly, withdrawal of this rejection under 35 USC § 103(a) is respectfully requested.

CONCLUSION

Applicants respectfully submit that the foregoing arguments obviate all of the outstanding rejections in this case and place the application in condition for immediate allowance. Allowance of this application is therefore earnestly solicited.

Respectfully submitted,

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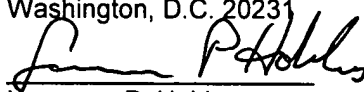
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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

The following changes are being made to claims 1, 8, 9 and 11:

1. (Twice Amended) An oligomerization process comprising contacting a hydrocarbon feedstock comprising sulfur-containing molecules with a hydrotreating catalyst in the absence of hydrogen at a temperature ranging from about 392°F to about 600°F.

8. (Amended) The process according to Claim 2, wherein said process is carried out at a temperature of from about [200°F] 392°F to about 500°F; a space velocity of from about 0.1 WHSV to about 100 WHSV; and a pressure of from about 50 psig to about 1000 psig.

9. (Amended) The process according to Claim 2, wherein said process is carried out at a temperature of from about [250°F] 392°F to about 450°F; a space velocity of from about 0.1 WHSV to about 100 WHSV; and a pressure of from about 50 psig to about 1000 psig.

11. (Amended) The process according to Claim 1 wherein said process is carried out at a temperature of from about [392°F] 400°F to about 500°F.